

## Claims:

1. A method of operating a mineral processing kiln having an inclined rotary vessel, the method comprising the steps of:

5       introducing combustion air and combustible fuel in a sub-stoichiometric ratio through a lower end of the rotary vessel, and

          introducing additional combustion air through an opening in a wall of the rotary vessel at a location between the lower end of the rotary vessel and an upper end of the rotary vessel.

10       2. The method of claim 1, wherein:

          the amount of air introduced through the lower end of the vessel and the amount of air introduced through the opening in the vessel wall define a total combustion air,

15       the ratio of the total combustion air and the combustible fuel introduced through the lower end of the rotary vessel defines a total air/fuel ratio, and

          the step of introducing additional combustion air comprises introducing an amount of combustion air sufficient to create a super-stoichiometric total air/fuel ratio.

20       3. The method of claim 1, wherein the step of introducing additional combustion air comprises introducing a mass flow rate of about 1% to about 15% of the rate of mass consumption of combustion air by the mineral processing kiln.

-25-

4. The method of claim 1, wherein:

the mineral processing kiln further has an air nozzle extending into the rotary vessel through the opening in the wall of vessel, and

the step of introducing additional combustion air comprises  
5 introducing additional combustion air through the air nozzle.

5. The method of claim 4, wherein:

the air nozzle has a pressurized air source coupled thereto, and

the step of introducing additional combustion air further comprises  
10 introducing pressurized air from the pressurized air source through the nozzle.

6. The method of claim 1, wherein the step of introducing additional air comprises introducing combustion air into a reducing zone of the rotary vessel.

15 7. A method of operating a lime kiln having an inclined rotary vessel, the method comprising the steps of:

advancing lime mineral from an upper end of the inclined rotary vessel to a lower end of the inclined rotary vessel,

introducing combustion air and combustible fuel in a sub-  
20 stoichiometric ratio through the lower end of the rotary vessel, and

introducing additional combustion air through an opening in a wall of the rotary vessel at a location between the lower end of the rotary vessel and the upper end of the rotary vessel.

-26-

8. The method of claim 7, wherein:

the step of advancing lime mineral comprises advancing lime mineral through a calcining zone of the rotary vessel to liberate CO<sub>2</sub> from the lime mineral, and

5 the step of introducing additional combustion air comprises introducing additional air into the calcining zone of the rotary vessel.

9. The method of claim 7, wherein:

the amount of air introduced through the lower end of the vessel and  
10 the amount of air introduced through the opening in the vessel wall define a total combustion air,

the ratio of the total combustion air and the combustible fuel introduced through the lower end of the rotary vessel defines a total air/fuel ratio, and

the step of introducing additional combustion air comprises  
15 introducing an amount of combustion air sufficient to create a super-stoichiometric total air/fuel ratio.

10. The method of claim 7, wherein the step of introducing additional combustion air comprises introducing a mass flow rate of about 1% to about 15% of  
20 the rate of mass consumption of combustion air by the lime kiln.

11. The method of claim 7, wherein:

the lime kiln further has an air nozzle extending into the rotary vessel through the opening in the wall of vessel, and

25 the step of introducing additional combustion air comprises introducing additional combustion air through the air nozzle.

-27-

12. The method of claim 11, wherein:

the air nozzle has a pressurized air source coupled thereto, and

the step of introducing additional combustion air further comprises introducing pressurized air from the pressurized air source through the nozzle.

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13. The method of claim 7, wherein the step of introducing additional

air comprises introducing combustion air into a calcining zone of the rotary vessel.

14. A method of controlling the air/fuel stoichiometry in a mineral

10 processing kiln, the method comprising the steps of:

advancing a combustible fuel into a lower end of a rotary vessel of the mineral processing kiln,

advancing a first quantity of combustion air into the lower end of the rotary vessel to create sub-stoichiometric conditions in the lower end of the rotary

15 vessel, and

advancing a second quantity of combustion air into the rotary vessel, at a location between the lower end of the rotary vessel and an upper end of the rotary vessel, to create super-stoichiometric conditions in a mid-portion of the rotary vessel.

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15. The method of claim 14, wherein the step of advancing the second

quantity of combustion air comprises advancing a mass flow rate of about 1% to about 15% of the rate of mass consumption of combustion air by the mineral processing kiln.

-28-

16. The method of claim 14, wherein:

the mineral processing kiln further has an air nozzle extending into the rotary vessel through the opening in the wall of vessel, and

the step of advancing the second quantity of combustion air comprises  
5 advancing additional combustion air through the air nozzle.

17. The method of claim 16, wherein:

the air nozzle has a pressurized air source coupled thereto, and

the step of advancing the second quantity of combustion air further  
10 comprises advancing pressurized air from the pressurized air source through the nozzle.

18. The method of claim 14, wherein the step of advancing the second quantity of combustion air comprises advancing combustion air into a reducing zone  
15 of the rotary vessel.

19. A method of operating a preheater/precaliner kiln having an inclined rotary vessel, the method comprising the steps of:

advancing mineral from a preheater/precaliner assembly into an upper  
20 end of the inclined rotary vessel,

advancing mineral from the upper end of the rotary vessel to a lower end of the inclined rotary vessel,

introducing a first quantity of combustion air and combustible fuel through the lower end of the rotary vessel, and

25 introducing a second quantity of combustion air through an opening in a wall of the rotary vessel at a location between the lower end of the rotary vessel and the upper end of the rotary vessel.

20. The method of claim 19, wherein the first introducing step comprises introducing combustion air and combustible fuel in a sub-stoichiometric ratio.

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21. The method of claim 19, wherein:

the step of advancing mineral comprises advancing mineral through a calcining zone of the rotary vessel to liberate CO<sub>2</sub> from the mineral, and

the step of introducing the second quantity of combustion air  
10 comprises introducing the second quantity of combustion air into the calcining zone of the rotary vessel.

22. The method of claim 19, wherein the step of introducing the second quantity of combustion air comprises introducing a mass flow rate of about  
15 1% to about 15% of the rate of mass consumption of combustion air by the preheater/precalciner kiln.

23. The method of claim 19, wherein:

the preheater/precalciner kiln further has an air nozzle extending into  
20 the rotary vessel through the opening in the wall of vessel, and

the step of introducing the second quantity of combustion air comprises introducing additional combustion air through the air nozzle.

-30-

24. The method of claim 23, wherein:

the air nozzle has a pressurized air source coupled thereto, and

the step of introducing the second quantity of combustion air further  
comprises introducing pressurized air from the pressurized air source through the  
5 nozzle.

25. The method of claim 19, wherein the step of introducing the  
second quantity of combustion air comprises introducing combustion air into a  
calcining zone of the rotary vessel.

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26. A mineral processing kiln, comprising:

an inclined rotary vessel having a lower end and an upper end, the  
rotary vessel having an air inlet opening defined therein at a location between the  
upper end and the lower end thereof,

15 a preheating/precalcining assembly positioned proximate to the upper  
end of the rotary vessel,

a stationary hood positioned proximate to the combustion air inlet end  
of the rotary vessel, and

a burner positioned proximate to the combustion air inlet end of the  
20 rotary vessel.

27. The mineral processing kiln of claim 26, further comprising an air  
nozzle extending into the rotary vessel through the air inlet opening of the wall of  
vessel.

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28. The mineral processing kiln of claim 27, further comprising a  
pressurized air source coupled to the air nozzle.

29. The mineral processing kiln of claim 26, further comprising a primary combustion air source adapted to advance combustion air through the stationary hood, wherein the primary air source and the burner are operable to create sub-stoichiometric air/fuel conditions in the lower end of the rotary vessel.

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30. The mineral processing kiln of claim 26, further comprising a mineral feed assembly operable to advance mineral into the upper end of the rotary vessel.

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31. A lime kiln, comprising:

an inclined rotary vessel having a lower end and an upper end, the rotary vessel having an air inlet opening defined therein at a location between the upper end and the lower end thereof,

a mineral feed assembly operable to advance lime mineral into the upper end of the rotary vessel,

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a stationary hood positioned proximate to the combustion air inlet end of the rotary vessel, and

a burner positioned proximate to the combustion air inlet end of the rotary vessel.

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32. The lime kiln of claim 31, further comprising an air nozzle extending into the rotary vessel through the air inlet opening of the wall of vessel.

33. The lime kiln of claim 32, further comprising a pressurized air source coupled to the air nozzle.

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34. The lime kiln of claim 31, further comprising a primary combustion air source adapted to advance combustion air through the stationary hood, wherein the primary air source and the burner are operable to create sub-stoichiometric air/fuel conditions in the lower end of the rotary vessel.